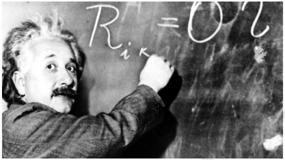
I. Physical quantities and their units - basic terminology

- The word physics comes from ancient Greek, ***fyzis*** it means nature.
- Physics was originally the science of nature.
- Gradually (with the increase of knowledge about nature) the sciences examining specific events in living organizations (biology) will be separated, sciences studying changes in the composition of substances (chemistry) and other natural sciences (astronomy, geology, mineralogy, ...)
- At present, physics creates a modern picture of the world (physical findings often result in technologies applied in practice).
- The subject of physics research are ***physical phenomena*** or ***physical objects***.

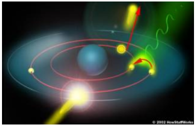
Division of Physics::

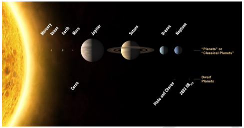
- ***from a historical point of view:***
  classical physics - knowledge acquired up to the end of the 19th century
  modern physics - knowledge gained since the beginning of the 20th century
- ***according to work methods:***
  theoretic physics – it searches for general laws and formulates theories from which he derives new knowledge by means of a mathematical apparatus
  experimental physics – it deals with the observation of phenomena that take place in nature spontaneously (movement of planets, cosmic rays), or are caused intentionally in a planned experiment
- ***according to the type of outputs:***
  basic physics - focused on acquiring new physical knowledge, its results do not need to be immediately applied in practice
  applied physics - deals with the use of physical knowledge in practice (in technology, electronics, medicine ...)



Albert Einstein:
„Look deep into nature and you will understand everything.“

Physical quantities





Physical properties, states and their changes that we can measure are expressed through ***physical quantities*** (length, weight, density, temperature, electric current, electric voltage...).

Physical quantity is a term used for qualitative and quantitative description of physical phenomena and objects.

Each physical quantity X is given by a numerical value of the physical quantity $\{X\}$ and its physical unit $[X]$.

$$X = \{X\}\,[\mathrm{X}]$$

$$m = 3\mathrm{kg}$$

Procedure for creating a system of quantities and units (from the 19th century):

1. A certain set of quantities is selected, which are called basic quantities.
2. The units of basic quantities are determined, i.e. basic units.
3. Other quantities are defined by means of defining quantity equations from basic quantities and already defined quantities, i.e. derived quantities.
4. The units of derived quantities are defined by defining unit equations from basic units, we call them derived units.
5. International System of Units SI (1960, Paris) - basic units, derived units, multiples and parts of units

$$p = \frac{F}{S}, [p] = Pa$$

$$[p] = \frac{[F]}{[S]} = \frac{[m \cdot g]}{[S]} = \frac{kg \cdot m \cdot s^{-2}}{m^2} = kg \cdot m^{-1} \cdot s^{-2} = Pa$$

Basic quantities and their units SI

Basic quantity	Mark	Basic unit	Mark
length	l	metre	m
mass	m	kilogram	kg
time	t	second	s
electric current	I	ampere	A
thermodynamic temperature	T	kelvin	K
amount of substance	n	mole	mol
luminous intensity	I	candela	cd

Additional quantities and their units

Additional quantity	Mark	Additional unit	Mark
plane angle	α, β, γ	radian	rad
solid angle	Ω	steradian	sr

Multiples and parts of SI units

Prefix	Mark	Power of ten
...	...	...
piko	p	10^{-12}
nano	n	10^{-9}
mikro	μ	10^{-6}
mili	m	10^{-3}
centi	c	10^{-2}
deci	d	10^{-1}
deka	da	10^{1}
hekto	h	10^{2}
kilo	k	10^{3}
mega	M	10^{6}
giga	G	10^{9}
tera	T	10^{12}
...	...	...

Measurement of physical quantities

Measurement of physical quantity - a set of activities that determine the value of a given physical quantity in selected units.

Measurement method - the way in which we determine the value of the measured quantity.

Direct methods - the result of the measurement is directly the value of the measured quantity, e.g. determination of temperature using a thermometer.

Indirect methods - the value of a physical quantity is determined on the basis of the result of direct measurement of auxiliary quantities, which are related to the measured physical quantity by a relation, e.g. determining the density of a liquid by volume and weight.

Actual value X_s - characterizes the measured quantity under the conditions at the time of measurement. It is an ideal concept, it is usually unknown. An exception is e.g. $g = 9,80665 m.s^{-2}$, $c = 299792459 m.s^{-1}$ (values ??specified by definition)

Measurement result X_m - numerical value obtained by measurement (data read on the scale of the meter, value obtained by calculation from measurement results, ...).

Measurement error - deviation of the measurement result from the actual value.

Absolute measurement error ΔX: $\Delta X = X_m - X_s$

Relative measurement error δX: $\delta X = \frac{\Delta X}{X_s}$

Measurement uncertainty - evaluation of the quality of the true value estimate

Scalar and vector physical quantities

Scalar physical quantity - scalar - is completely determined by one data, i.e size in the selected unit. For example temperature, weight, time...

Vector physical quantity - vector - it is determined not only by size but also by direction. For example speed, acceleration, force...

We will denote the vectors by oriented lines. For example $\vec{F}$, $\vec{v}$,...

We will denote the size of the vector $\left|\vec{F}\right|$, $|\vec{v}|$,...

Interesting links:

https://en.wikipedia.org/wiki/International_System_of_Units#SI_metric_prefixes_and_the_decimal_nature_of_the_SI_system

https://www.youtube.com/watch?v=oAtDAoqdExw

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